ADVANCING INDUSTRIAL ENGINEERING IN NIGERIA THROUGH TEACHING, RESEARCH AND INNOVATION

A BOOK OF READING

Edited By
Ayodeji E. Oluleye
Victor O. Oladokun
Olusegun G. Akanbi

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(A Festchrift in honour of Professor O. E Charles-Owaba)

Professor O. E. Charles-Owaba

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FOREWORD

It gives me great pleasure writing the foreword to this book. The book was written in recognition of the immense contributions of one of Nigeria's foremost industrial engineers, respected teacher, mentor, and lover of youth – Professor Oliver Charles-Owaba.

His commitment to the teaching and learning process, passionate pursuit of research and demonstration of excellence has prompted his colleagues and mentees to write this book titled – Advancing Industrial Engineering in Nigeria through Teaching, Research and Innovation (A Festschrift in honour of Professor O. E Charles-Owaba) as a mark of honour, respect and recognition for his personality and achievements.

Professor Charles-Owaba has written scores of articles and books while also consulting for a medley of organisations. He has served as external examiner to various programmes in the tertiary educational system. The topics presented in the book cover the areas of Production/Manufacturing Engineering, Ergonomics/Human Factors Engineering, Systems Engineering, Engineering Management, Operations Research and Policy. They present the review of the literature, extension of theories and real-life applications. These should find good use in the drive for national development.

Based on the above, and the collection of expertise in the various fields, the book is a fitting contribution to the corpus of knowledge in industrial engineering. It is indeed a befitting gift in honour of erudite Professor Charles-Owaba.

I strongly recommend this book to everyone who is interested in how work systems can be made more productive and profitable. It represents a resourceful compilation to honour a man who has spent the last forty years building up several generations of industrial engineers who are part of the process to put Nigeria in the rightful seat in the comity of nations. Congratulations to Professor Charles-Owaba, his colleagues and mentees for this festschrift.

Professor Godwin Ovuworie
Department of Production Engineering
University of Benin

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CHAPTER 2

Options for the Nigeria Electricity Tariff Review: Cost or Service Reflective Tariff?

Akinlabi, K.A.[1], Oladokun, V.O.[1], Alexander A.O.[2]

[1] Department of Industrial and Production Engineering, University of Ibadan, Ibadan Nigeria
[2] Centre for Petroleum, Energy Economics and Law, University of Ibadan, Ibadan Nigeria
Corresponding emails:tundelabi@yahoo.com, vo.oladokun@mail1.ui.edu.ng, akolo.xander@gmail.com

Abstract: The improvement in the Nigerian electricity value chain has not been visible after seven years of partial privatization of the sector as the government continues to subsidize tariffs to avert the total collapse of the sector. The electricity distribution companies tagged the weak link in the value chain, have been challenged with inherited dilapidated infrastructure and poor revenue generation. The Nigeria Electricity Supply Industry is currently considering service reflective tariff options after her inability to implement a cost-reflective tariff in the sector since privatization in 2013. The electricity value chain is presently challenged with poor cash flow due to customer payment apathy, perceived corruption in the system, unavailability of a cost-reflective tariff which resulted in poor remittance to the value chain by the distribution companies. This paper reviews the power sector evolution and the reforms in the sector, the performance of Nigeria Electricity Regulatory Commission regulations, the concepts of the cost, and service reflective tariff. The paper recommends a cost-reflective tariff option with strict regulatory performance monitoring of all the value chain participants in the sector.

Keywords - electricity value chain; privatization; service reflective tariff, cost-reflective tariff, electricity distribution, Nigeria power sector

1.0 INTRODUCTION

The level of infrastructural development of a country will determine her rate of attainment of sustainable development and economic growth (Elum & Mjimba, 2020). A good understanding of infrastructural service performance, especially electricity, is critical for planning and policymaking to achieve vibrant economic development. Nigeria is a developing nation with a population of 203 million over the 923,768km^2 area it covers (CIA, 2019). The International Energy Agency and the World Bank reported in 2017 that 58% of Nigeria's population is connected to electricity through the national grid. In 2019, the United States Agency for International Development (USAID) estimated the installed electricity generation capacity in Nigeria to be 12,522MW with daily generation hovering above 4,000MW. Oyedepo (2012) opined that the instability of electricity supply from the national grid resulted in 80% of consumers being underserved with only a few hours of supply daily. Thus, consumers have resulted in self-generation of electricity from renewable and non-renewable sources to be able to meet their energy needs. There are many issues with electricity supply which make the distribution from the national grid epileptic and cover only about 40% of the country's population (Aliyu *et al.*, 2013). According to Seymour, (2012) and Titus *et al.*, (2013), service outages could arise from transmission lines failure, traffic accidents, switching problems at injection substations, heavy start-up loads, background electrical noise, faulty distribution components, and lack of scheduled preventive maintenance. However, a very critical issue that determines the sustainability of the power sector, especially a deregulated power sector, is the tariff (Oladokun & Asemota, 2015). Recovery of cost in the value chain and avoidance of cross-subsidies by customers are two critical issues for consideration when setting right price in transition economies (Reneses *et al.*, 2011).Meanwhile, there are no policy consensus on the

tariff regime that is most suitable for Nigeria viz a viz cost and service reflectivity of the regime (Nwangwu, 2019). The current tariff being charged electricity users in Nigeria is neither service nor cost-reflective and this is hurting the entire value chain. The section 2 of this paper reviews the history of electricity in Nigeria, the power sector reform and the electricity distribution company. The Nigeria electricity value chain is discussed in section 3 while section 4 details the electricity tariff building blocks in Nigeria. The section 5 explains the difference between the cost and service reflective tariff in Nigeria context while the authors' recommendation and conclusion can be found in the last section.

2.0 HISTORY OF ELECTRICITY IN NIGERIA

Nigeria started generating electricity in the Lagos colony with two small generators in 1886. A 60kW generator was introduced to power Lagos in 1896, after fifteen years of electricity introduction in England (Niger Power Review, 1985; Sambo, 2010; Onochie *et. al.* 2015). The foremost utility company that started operations in 1929 was the Nigeria Electricity Supply Company (NESCO), with a hydroelectric power station located in Kurra, near Jos. In 1964, the Nigerian Government Electricity Undertaking (NGEU) was established as part of the Public Works Department, to oversee both liabilities and assets of electricity distribution in Lagos. An act of Parliament was enacted in 1951 to create the Electricity Corporation of Nigeria (ECN). ECN was responsible for the integration of both privately-owned and government-owned power generating systems (Awosope, 2014). In February 1956, the Ijora power station was launched to increase accessibility and supply quality to Ikorodu, Shagamu, Ijebu-ode, and more cities in the Ibadan-Ijebu bloc leading to remarkable improvement in the economic activities in southwest states.

In 1962, another act of parliament was enacted to establish the Niger Dams Authority (NDA), and the first 132KV line was constructed to link Ijora generating plant to Ibadan generating plant. NDA was responsible

for the development of hydroelectricity generation through the building and preservation of dams on the Niger River and beyond, improving navigation, supporting fish brine, and irrigation activities (Manafa, 1995). The renowned Kainji dam was constructed between 1962 and 1968. The Niger Power Review (1989) stated that the combined contribution of defunct NDA and ECN led to the commencement of the operations of the national grid in 1966. The grid power transmission system linked Lagos with Kainji. The connection between Kaduna and Kainji was increased up to Kano and Zaria. In the same vein, the construction grid network of the Benin-Onitsha-Afam and Oshogbo-Benin-Ughelli were done in the Nigerian southern region. The NDA was the generating company while ECN was the distribution company selling electricity to customers.

The National Electric Power Authority (NEPA) was established from the merger of NDA and ECN on the 1st of April 1972. The merger commenced with the appointment of the first manager for NEPA in January 1973. ECN was primarily in charge of sales and distribution and the NDA established to construct and operate transmission lines and power generating stations. The major reason for the merger is vesting authority for power production and distribution throughout Nigeria in one company which would also be accountable for the financial obligations. It will also lead to the useful utilization of resources available, financial, human, and other resources available in the industry across Nigeria. Okoro &Madueme (2004) stated in their study that despite annual network expansion since the inception of NEPA, the electricity supply is not regular, and the current electricity connection access rate at 45% (USAID, 2019). Meanwhile, the federal government, between 1978 and 1983, established two committees to develop templates for restructuring NEPA into an efficient and autonomous entity in readiness for its unbundling and privatization. In 2005, NEPA was renamed as Power Holding Company of Nigeria (PHCN) and takes responsibility for the entire power sector in readiness for the reforms (Sambo, 2008).

2.1 **Nigeria Power Sector Reform**

Nigeria's power sector is responsible for the supply of quality and reliable electricity for residential, commercial, and industrial activities. In 2002, the Federal Ministry of Economy affirmed that the Power sector is a vibrant and important part of the economic value chain playing a very strategic role in the remaining sectors of the economy. Oyedepo *et al.*, (2012) opined that inadequate power supply will impede commercial and industrial activities, the establishment of infrastructural facilities, and other social amenities. To this end, continuous improvement in power generation and distribution should be the utmost priority for all the participants in the power sector to achieve the desired growth. To have continuous growth in the sector, there has been an evolution to search for the way forward in resolving the enormous issues facing the sector over the last decades.

The Nigeria government embarked on massive power infrastructures rehabilitation from 1999 to 2004 in response to the pathetic state of the electricity supply (Lawal, 2008). This phase of the reform is known as the National Integrated Power Project (NIPP). Power plants were established at different parts of the country to improve power generating capacity through NIPP projects across the nation (REMP, 2005). In furtherance of the power infrastructure expansion program, licenses for power generation were granted to various Independent Power Producers (IPPs). The IPPs sell their generated electricity to private utilities and the public through the distribution companies (Adedayo & Yong 2010). In 2005, the Federal Government of Nigeria enacted the Power Sector Reform Bill into law with the key objective of deregulation of Nigeria Electricity Supply Industry (NESI) within two years of implementation. A major notable achievement of the reforms is the successful unbundling of PHCN into 18 succession companies – 11 DISCOs - distribution companies, 6 GENCOs - generation companies, and TCN – Transmission Company of Nigeria. The unbundling of PHCN is in readiness for privatization which was delayed due to change in government, policy inconsistency, administrative bureaucracy, and opposition by the workers' union (Onochie *et al.,* 2015).

Other achievements include the setting up of institutional framework and regulatory bodies such as the Nigeria Electricity Regulatory Commission (NERC), the Nigeria Bulk Electricity Trading Company (NBET), and the implementation of a Multi-Year Tariff Order – MYTO regime designed to achieve a cost-reflective tariff. The NERC was inaugurated on November 1st, 2005, as a regulatory body overseeing activities in the power sector including tariff regimes (Okafor, 2017). Other regulatory bodies created are the Nigeria Bulk Electricity Trading Plc (NBET) which oversees buying and selling of electric power and provision of ancillary services for the successor generation companies and the independent power producers. The Nigeria Electricity Liability Management Company (NELMCO) was established to take over the remaining PHCN assets and liabilities while the Rural Electrification Agency (REA) was created to ensure the expansion of electricity to the unserved area, oversees the development, and uphold transparency in the sector (Idemudia and Nordstrom, 2016).

The Federal Government sold 80% and retain 20% of the GENCOs. The GENCOs are Afam, Egbin, Kainji, Sapele, Shiroro, and Ughelli. There are some Independent Power Producers (IPPs) which are connected to the grid under the auspices of the Niger Delta Power Holding Company (NDPHC), while other IPPs are still under construction. The Nigerian Electricity Supply Industry (NESI) currently has 23 grid-connected power generation stations in operation with a total installed capacity of 12,522 MW (USAID, 2019) and an available capacity of 6,056 MW as of 10th of May 2019. The peak energy is 109,372.01 MWH and peak generation to date is 4602.4 MW (Okafor, 2017; Sambo, 2018). The thermal-based plant is prevalent with an installed capacity of 10,142 MW (81% of the total) and an available capacity of 4,996 MW (83% of the total). The total installed capacity of the three Hydropower generation stations is 1,938MW with an available capacity of 1,060MW. According to IEA, the Gas Thermal Plant with 64%, Hydro with 23%, and Steam Thermal Plant with 13% made up the total installed electricity generation

in Nigeria. Figure 1 shows the Nigeria Power Sector Structure with the main participants.

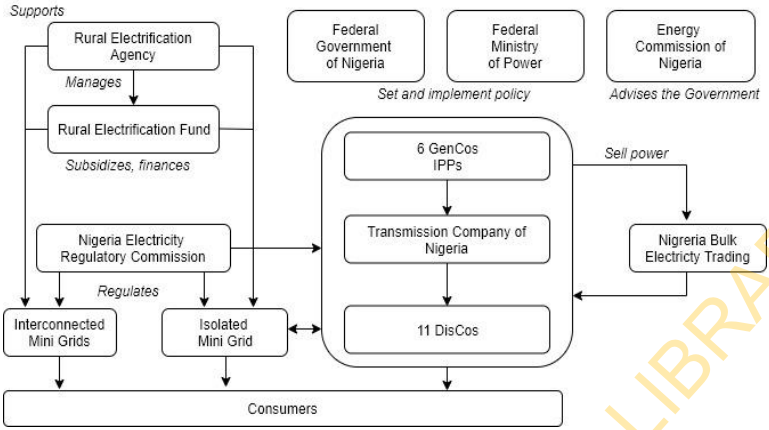

Fig. 1: **Nigeria Power Sector Structure**

Source: Energy Sector Management Assistance Program - ESMAP (2017)

The Federal Government still fully owned the Transmission Company of Nigeria (TCN) out of 18 successor companies unbundled from PHCN. The transmission asset was managed on a 4-year contract, on behalf of the government by Manitoba Hydro International (MHI Canada) whose responsibility is to revamp the network and wheel power from generating plants to distribution companies' infrastructure without system failure. MHI contract ended in August 2016 without achieving its objective and the government did not renew the contract. TCN is now being managed by the Federal Government and Nigerians. TCN has three operational departments: System Operations (SO), Transmission Service Provider (TSP), and Market Operations (MO). The System Operations is responsible for electricity flow from generation to distribution systems, control of electricity on the grid, dispatch, system operations planning, and grid reliability. Transmission Service Provider is responsible for transmission infrastructure development, operations, and maintenance. The Market Operations overseethe administration of the NESI market rules, the wholesale electricity market, and promoting efficiency (Onochie *et al.*, 2015).

TCN grid network of 20,000km transmission lines has anoverall (theoretical) wheeling capacity of about 7,500MW. The transmission system footprint does not cover every area of Nigeria (Sambo, 2010). A new generation and transmission peak of 5,375MW was achieved on Thursday 7th February 2019 at 2100hrs (TCN, 2019). There are acute infrastructure and operational challenges on the grid network. The network infrastructure is radial without redundancies consequently leading to an unreliable and technically weak grid with frequent failure due to major disturbances. The transmission losses on the network are approximately 7.4% which is higher than the 2 – 6% benchmark for emerging countries.

2.2 Electricity Distribution in Nigeria

A major outcome of the reform in the electricity sector was the unbundling of PHCN into eleven distribution companies – DISCOs, one transmission company – TCN, and six generation companies – GENCOs. The Federal Government sold 60% of the eleven electricity distribution companies (DISCOs) to the private investors and retains 40% ownership. The eleven DISCOs are EKEDC - Eko Electricity Distribution Company, Ikeja Electric (IE) in Lagos State, IBEDC - Ibadan Electricity Distribution Company covering the Southwest States, BEDC - Benin Electricity Distribution Company with franchise across the mid-western states, the eastern states were covered by Enugu Electricity Distribution Company - EEDC, KEDC - Kaduna Electricity Distribution Company, KEDCO - Kano Electricity Distribution Company, YEDC - Yola Electricity Distribution Company, JEDC - Jos Electricity Distribution Company covering the northern states, AEDC - Abuja Electricity Distribution Company for the federal capital territories and its environ and PHEDC - Port-Harcourt Electricity Distribution Company for the southern states. The available electricity on the grid is allocated to all the distribution companies as seen in Table 1 that shows the percentage Load Allocation for each DISCO. TheNigeria Electricity Distribution Network Map in Figure 2 shows the coverage area of each distribution company.

Table 1: Load Allocation for DISCOs. Source TCN (Oct. 2013)

s/n	1	2	3	4	5	6	7	8	9	10	11
DISCOs	*Abuja*	*Benin*	*Eko*	*Enugu*	*Ibadan*	*Ikeja*	*Jos*	*Kaduna*	*Kano*	*Port Harcourt*	*Yola*
% Load Allocation	*11.5*	*9*	*11*	*9*	*13*	*15*	*5.5*	*8*	*8*	*6.5*	*11.5*

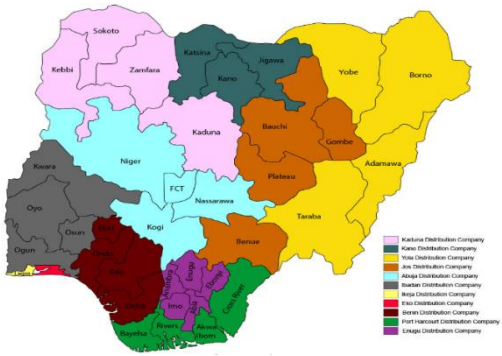

Fig. 2:Nigeria Electricity Distribution Network Map
Source:https://www.nbet.com.ng/

3.0 NIGERIA ELECTRICITY VALUE CHAIN

Electricity is generated from different fuel sources like coal, hydro, natural gas, solar, wind biomass, and other renewable and unconventional sources. Natural gas is responsible for 80% of electricity generation in Nigeria (UNDP 2016), therefore the value chain would be incomplete without the gas suppliers. The electricity value chain comprises gas suppliers (producers and transporters), generation (independent power producers - IPPs), transmission and distribution companies, and the end-user – customers. The cost of gas (in the US dollar) is a key determinant in the pricing unit of electricity. The generating company signs a gas supply agreement with the natural gas supplier while NBET reviews the contract for risk allocation. The electricity flow commences from transporting gas to the generation companies to fire their turbines. The generation companies (IPPs) sign a

power purchase agreement (PPA) with NBET while the latter issues bank guarantees for bulk electricity purchased from IPPs. The electricity produced is wheeled by TCN -transmission company of Nigeria to the eleven DISCOs - distribution companies through high voltage 330kv and 132kv cable network spanning several kilometers. TCN sends data to NBET for IPPs invoice verification and invoices to DISCOs. The DISCOs distribute electricity to the customers from their injection substations through low voltage 33kv and 11kv lines to various distribution transformers. Monthly bills (invoices) are issue to customers for settlement or purchase energy for their meters (Pre-paid) before consumption. Figure 3 shows the Nigerian electricity supply industry (NESI) value chain with participants' roles.

The industry average collection efficiency is currently 60% with residential customers responsible for the highest default in bills payment. The market operator issues invoices to all distribution companies for energy received from the grid monthly. The invoices are for market operators and NBET bills. The market operator's invoice is for the transmission tariff paid to TCN. The NBET bill is for the power purchase agreement (PPA) and capacity-energy charge for the month paid to the generation companies. DISCOs also pay regulatory charges to NERC while retaining only 26% of collections from the customers. GENCOs pay for gas supply and transportation in US dollars to the gas producers and transporters while the producers settle royalties and hydrocarbon taxes. All payments in the value chain are made in Naira except for gas supply and transportation. Figure 4 shows the electricity and cash flow in the value chain.

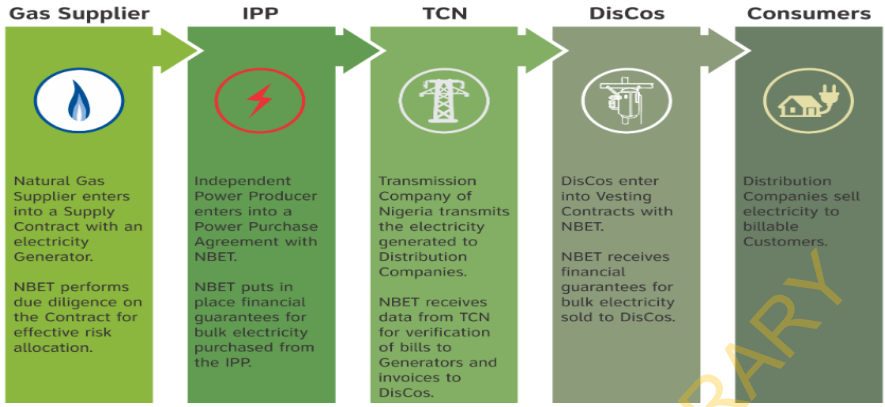

Fig. 3: Nigeria Electricity Supply Industry (NESI) Value Chain
Source: Nigeria Bulk Electricity Trading Company

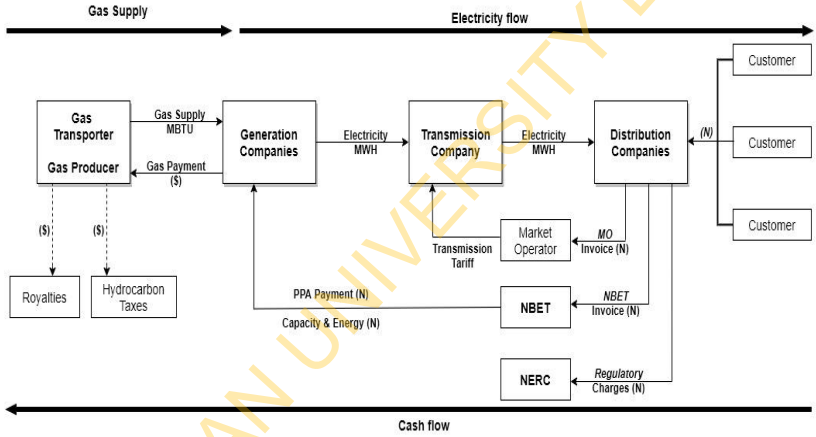

Fig. 4: **Electricity and Cashflow in Value Chain**

4.0 NIGERIA ELECTRICITY TARIFF BUILDING BLOCKS

Nigeria's government did not allow both minor and major tariff review since 2016. The current electricity tariff is due for a change because the last minor review was done in February 2016. There have been changes in macroeconomic indexes such as gas price, exchange rate, and inflation but tariff remains because most customers are against it due to poor

supply and services. This has great implications on the market as revenue shortfall is being rammed up with a total of N1.1trillion tariff shortfall in 2019 and 2020 (EMRC, 2020). The situation is further worsened because of poor revenue collection from the residential and government customers is causing the distribution companies to accumulate huge debts.

The Act which sets the background for the Nigerian power industry is called the Electric Power Sector Reform Act (EPSRA) 2005.Section 32 (d) of this Act highlights the mainresponsibilities of the NERC. One of the NERC's responsibilities is toguarantee that the prices charged by licensees are fair to customers whilst allowing the licensees to finance their activities and obtainingrational profits. In agreementwith Section 76 (2) of the Act, the NERC set a frameworktoset electricity prices which arecalled the Multi-Year Tariff Order (MYTO). The MYTO aims to reward stakeholders that perform above certain thresholds, whilst also reducing the aggregate technical commercial and collection losses, hence leading to the recovery of costs and an overall performance standards improvement. The NERC uses the MYTO to fix the bulk and retail prices for electricity in the NESI by using anintegratedmethod to ascertain the revenue requirement for the power sector.

The objective of the MYTO is to fix tariffs that are cost-effective thereby causing the NESI to be self-sufficient. It delivers a tariff path for a period of 15-years for the NESI, with two minor reviews every year and a major review every 5 years. These reviews are conducted when it has been determined that there are fluctuations or changes in the macroeconomic variables used in tariff computation (for exampleexchange rates, inflation, interest rates, and generation capacity). All the variables will be appraised by the market participants during the reviews. The intents of the MYTO are:

- Recovery of costs and viability of the NESI to guarantee a realistic rate of returns on investment by the participants
- Provision of Key Performance Incentives that are modest and achievable

- Certainty and Steadiness of the pricing methodologythat boosts an effective capital injection into the industry
- Risk Allocation is efficiently done among the participants

In setting the tariffs for the NESI, the MYTOemploys the building blocks approach.This methodallows a combined advantage of the incentive-based regulations and price capping. The MYTO is premised on combining all costs in a dependable accounting methodology. The MYTO is built on three building blocks below to allow the returns on capital in achieving the following: -

(a) A fair rate of returns on capital invested
(b) Recovery of capital over the depreciation period of assets
(c) Well-managed overheads and operating costs.

Some macroeconomics indices that were considered in arriving at the tariff are exchange rate, inflation, invested capital, return on capital, generating capacity, load forecasts, aggregated technical, commercial & collection (ATC&C) losses, fuel costs, operating and maintenance costs, other technical data, customer population, etc. The minor tariff reviews have been scheduled for June and December of every year by NERC while a major review of the industry's pricing structure comes up every five years.

5.0 COST REFLECTIVE TARIFF VERSUS SERVICE REFLECTIVE TARIFF

Cost Reflective Tariff (CRT) regime is when the tariff charge for electricity have put into consideration all the inputs and parameters in the value chain before arriving at the pricing in a way that aligns electricity tariff with the cost of providing network services to customers (Passey., Haghdadi, Bruce, & MacGill, 2017). On the other hand, Service Reflective tariff (SRT) is based on availability hours of supply to incentivize the distribution companies toward improving their service by investing in network rehabilitation and upgrade. The CRT is the same for all customers while SRT is not the same across the board. Customers have been categorized using the electricity network feeders and distribution transformers. This makes it easy to track the availability hours of supply and thus determine the tariff. In the SRT regime, tariff increases according to the number of hours of supply. Nigeria as a transition electricity market has plans to achieve CRT gradually and in phases.

However, the NERC failed to adjust the macroeconomic indices to achieve cost reflectivity in the Nigeria Electricity Supply Industry since 2016. The Power Sector Recovery Plan makes provision for a steadychange to cost-reflective tariffs with protections for the lesserincome earners in the country. NERC proposed atransitional review in consumer tariffs on January 1, 2020, and a gradual transition to full cost-reflective tariffs shall be attained by July 2020. The review of basic assumptions in the MYTO is highlighted in the 2016 -2018 Minor Review of MYTO 2015 and Minimum Remittance Order for the Year 2019. This review covers changes to these parameters: loss target, Nigerian Inflation Rate, US$ Exchange Rate, Daily Generation Capacity, Transmission & Administrative Costs, Tariff and Market Shortfalls, etc. Thus, it aimed to provide some certainty about revenue shortfall that might have arisen due to tariff misalignment between the MYTO tariff and Cost Reflective Tariff. Table 4 below provides a summary of the actual and projected indices for 2015 to 2021.

Table 4: Macro-Economic Indices of MYTO and Non-Cost-Reflective Tariffs

MYTO Indices	MYTO 2015 Assumptions	The Reality	% Variance
Nigerian Inflation	8.80%	12.20%	30%
U.S. Inflation	0.20%	1.54%	650%
Debt Interest Rate	9.70%	20%	107%
Naira Vs USD$ Exchange Rate (₦)	198.97	361	54%
Generation (MW)	5,465	4,369	-20.0%

Source: NERC Website

Due to the prevalence of the COVID-19 pandemic across Nigeria, the NERC suspended the implementation of the cost-reflective regime in July 2020, thereby invariably creating a further tariff shortfall in the electricity market. Under this regime, customer tariff classes were categorized into residential (R1, R2, R3, R4), commercial (C1, C2, C3, C4), industrial (D1, D2, D3), special (A1, A2, A3), and Street Lighting (S1). Conversely, on September 1, 2020, the Nigerian Electricity Regulatory Commission published the MYTO 2020, which introduced the Service Reflective Tariff (SRT) regime across the country. This became necessary due to the high number of complaints received by the Commission at the public hearings held across the country, in the first quarter of 2020, during the Commission's consideration of the DISCOs' application for an extraordinary tariff review.

The Service Reflective Tariff (SRT) regime categorizes electricity customers into five (5) Service Bands based on the daily availability hours of supply. The service bands are: -

- Band A - a minimum of 20 hours supply daily
- Band B - minimum of 16 hours supply daily but less than 20 hours daily
- Band C - minimum of 12 hours supply daily but less than 16 hours daily
- Band D - minimum of 8 hours supply daily but less than 16 hours daily

- Band E - minimum of 4 hours supply daily but less than 8 hours daily

The new tariff regime further collapses the tariff classes into three (3) classes namely lifeline (LFN), non-maximum demand (NMD), and maximum demand customers (MD1 and MD2). The rate methodology is directly tied to the hours of electricity supply by associated feeders. The Commission aimed to incentivize the DisCos to invest in their networks to earn more by charging higher tariffs when availability hours improves. By implication, DisCos can meet their revenue requirements when they invest in their network rehabilitation and upgrade to achieve an increase in supply. The difference between the old tariff regime and the new SRT is shown in Table 5.

Table 5: Differences between the old tariff regime and the Service Reflective Tariff

INDICES	OLD TARIFF	SERVICE REFLECTIVE TARIFF
Rate Design	Rates/tariff designed at Disco level without regard to hours of supply in the different locations covered	Rates/tariff designed at feeder level recognizing the hours of supply on each feeder
Feeder Clustering	Not Applicable	Basis of rate design is clustering of feeders by Hours of Supply into 5 clusters
Number of Tariff Classes	Customer base classified by type into 14 classes (Residential, Commercial, Industrial, Special)	Customer base classified by type into 3 classes (Lifeline, Maximum Demand and Non-Maximum Demand)

6.0 RECOMMENDATION AND CONCLUSION

The power sector reforms are guided by government policies and regulations to ensure the success of the program. Unfortunately, there are extensive regulatory and policy changes as the government keeps given directives that are not in favour of the participants in the electricity sector. The commitment signed by both the government and investors at

privatization is not adhered to and the government cannot hold investors for not fulfilling their obligations since they are equally guilty. This policy inconsistency is a great disservice to the sector as it discourages local and foreign investors. A good example is the non-implementation of the Multi-Year Tariff Order as required while the government continues to subsidize the unit cost of electricity.

This review has shown that inappropriate pricing of electricity in Nigeria is a major challenge to the progress that the reforms in the power sector are supposed to have gained in the past. The tariff shortfall created by the lack of cost-reflective tariff led to a dearth of required investment in the sector because of its liquidity problems. This is evidenced in the level of the dilapidated network infrastructure as DISCOs' investment in network rehabilitation is very low compared to requirements. New GENCOs and IPPs are not coming in despite the huge energy gap that is available for new investors. It is also very difficult to get loans from the financial institution due to the poor and risky nature of the participants' balance sheets. This liquidity crisis in the sector is expected to be relieved with the implementation of a cost-reflective tariff. This will encourage investors and private developers to invest in the sector. Prepaid metering is a good strategy as customers will have to pay for supply before consumption thus eliminating debt accumulation. A true cost-reflective tariff will be shocking to consumers but the further delay in implementing this will be more aching when it is eventually done. The new service reflective tariff introduced on September 1, 2020, was halted barely one month after introduction because the workers' unions gave notification of a nationwide strike to ground the economy. Government and workers' unions will negotiate to bring down the SRT pricing and pay for the shortfall.

Conclusively, we recommend regular annual tariff review to make up for changes in macroeconomic indexes until a cost-reflective tariff is reached. This will restore confidence in the industry and encourage both foreign and local investors to invest in the power sector. Customers will

be willing to pay a cost-reflective tariff if there is a remarkable increase in supply. The service reflective tariff is a fallacy because the cost of 1kwh of electricity is the same whether customers get the supply for 20hours or just 1 hour. It is like robbing Peter to pay Paul as a customer living in a location with better supply will be paying far higher tariff than customers where supply is not sufficient, which is not the customer's making. Finally, the recent agreement signed by Nigeria and German governments for Siemen's electrification roadmap should be taken business-like. This program is funded by the government for upgrades and development of generation, transmission, and distribution capacities with the target of 25000MW. The government should ensure that projects are not abandoned but completed to standards and specifications.

REFERENCES

Adedayo, Z. & Yong, L. (2010). "Impact of Domestic Natural Gas Pricing on Electricity Tariffs in Nigeria" IEEE Trans. Power system.

Aliyu, A., Ramli, A., Saleh, M., (2013). Nigeria electricity crisis: Power generation capacity expansion and environmental ramifications. *Energy,* 61(8), pp. 354-367

Awosope C.A. (2014). Nigeria Electricity Industry: Issues, Challenges, and Solutions. Covenant University 38th Public Lecture Series, Vol.3, No. 2. October 2014.

Central Intelligence Agency US (2019). The World Factbook — Central Intelligence Agency, *www.cia.gov*. Retrieved 2019-02-23

Elum, Z. A., & Mjimba, V. (2020). Potential and challenges of renewable energy development in promoting a green economy in Nigeria. *Africa Review, 12* (2), 172-191.

Energy Market and Rates Consultants (2020). Nigeria Electricity market insights (NEMI). An EMRC Report – January 2020. http://www.energy-mrc.com

Energy Sector Management Assistance Program - ESMAP (2017). Mini-Grids in Nigeria: A Case Study Of A Promising Market. Written

by Castalia Strategic Advisor, Conference Edition, Washington DC, Available at https://www.esmap.org/

Idemudia, I. G. and Nordstrom, D. B. (2016). Nigerian Power Sector: Opportunities and Challenges for Investment in 2016. Number 1930, 1 – 15, Latham & Watkins, Lagos, Nigeria.

Lawal, L. 2008. "Nigeria: A Case Study in Power Shortages" Energy Tribune, April 10, 2008.

Manafa N. (1995), Electricity Development in Nigeria, Rasheen Publisher, Lagos, 1995, pp.37-51.

Niger Power Review (1985). Development of the Electricity Industry in Nigeria (1960-1985), pp. 1-6.

Niger Power Review (1989). Development of the Electricity Industry in Nigeria (1960-1989), pp. 10-15.

Nwangwu, G. (2019). Quest for cost-reflective electricity tariffs in Nigeria: Managing the conflict between politics and economics. *Nnamdi Azikiwe University Journal of International Law and Jurisprudence, 10* (1), 158-165.

Okafor, F. N. (2017). Improving Electric Power Sector Performance: The Role of Nigeria Electricity Regulatory Commission. Nigerian Academy of Engineering Public Lecture held on March 29, 2017, at the University of Lagos, Akoka, Lagos, Nigeria, 1-14.

Okoro O.I. and Madueme T.C. (2004). "Solar Energy Investments in a Developing Economy", Renewable Energy, vol. 29, 2004, pp. 1599-1610.

Oladokun, V. O., & Asemota, O. C. (2015). Unit Cost of Electricity in Nigeria: A Cost Model for Captive Diesel Powered Generating System'. *Renewable & Sustainable Energy Reviews, 52*, 35-40.

Onochie, U.P., Egware, H.O., Eyakwanor, T.O. (2015). The Nigeria Electric Power Sector (Opportunities and Challenges) *Journal of Multidisciplinary Engineering Science and Technology (JMEST)* ISSN: 3159-0040 Vol. 2 Issue 4.

Oyedepo, S.O. (2012). Energy and sustainable development in Nigeria: The way forward. *Energy Sustainability and Society*, 2(15): 1-17

Passey., R., Haghdadi, N., Bruce, A., & MacGill, I. (2017). Designing more cost-reflective electricity network tariffs with demand charges. *Energy Policy, 109*, 642-649.

Reneses Javier, GómezTomás,RivierJuan,.AngaritaJorge L. (2011). "Electricity tariff design for transition economies: Application to the Libyan power system" *Energy Economics*, volume 33, issue 1, pages 33-43.

Sambo A.S. (2008). Matching Electricity Supply with Demand in Nigeria. *International Association for Energy Economics*. Fourth Quarter, pp 32 – 36

Seymour, J. (2012). The Seven Types of Power Problems, s.l.: Schneider Electric – Data Center Science Center.

Transmission Company of Nigeria (2019): Transmission Company of Nigeria. www.tcnorg.com

Titus Koledoye Olugbenga., Abdul-Ganiyu A. Jumah., Phillips D. A., (2013). The current and future challenges of the electricity market in Nigeria in the face of the deregulation process. *African Journal of Engineering Research.* Vol. 1(3), pp. 33-39

UNDP Nigeria 2016 Annual Report (2017). United Nations Development Programme Nigeria media.ng@undp.org www.ng.undp.org

USAID (2019): NIGERIA – Power Africa Fact Sheet. www.usaid.gov.